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IS 11537 (1985): Centrifugal switch for single phase induction motors [ETD 15: Rotating Machinery]



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IS : 11537 - 1985
(Reaffirmed 1995)

Indian Standard

SPECIFICATION FOR CENTRIFUGAL SWITCH FOR SINGLE-PHASE INDUCTION MOTORS

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BIJREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

SPECIFICATION FOR
CENTRIFUGAL SWITCH FOR
SINGLE-PHASE INDUCTION MOTORS

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(Continued on page 20)

Indian Standard

SPECIFICATION FOR CENTRIFUGAL SWITCH FOR SINGLE-PHASE INDUCTION MOTORS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 9 December 1985, after the draft finalized by the Rotating Machinery Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 The centrifugal switch is used in single phase induction motors (for example, split phase motors and capacitor start capacitor run) as a control device to disconnect the auxiliary windings or capacitor once the predetermined speed is reached. The centrifugal switch again connects these windings or capacitors if the speed of motor falls below the predetermined value.

0.3 ~~Once~~ the single phase motor develops a predetermined speed (see 6.1), the auxiliary windings and/or capacitor (in case of split phase motors) is disconnected from the power supply for the following reasons:

- a) To produce designed rated torque,
- b) To reduce losses due to presence of auxiliary windings,
- c) To avoid failure of auxiliary windings, and
- d) To safeguard against the failure of starting capacitor.

0.4 The construction and mountings dimensions of centrifugal switch are not included in the standard and these should be agreed between the manufacturer and the user.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with **IS : 2-1960***. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers general requirements and tests for the centrifugal switch used in single phase induction electric motors. It does not cover two contact type centrifugal switches for special application.

*Rules for rounding off numerical values (*revised*).

1.2 The standard requirements of single phase induction motors are covered separately in IS : 996-1979*.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions, in addition to those given in IS : 1885 (Part 35)-1973†, shall apply.

2.1 Centrifugal Switch — It is a speed dependent switch for switching the auxiliary windings and/or capacitor in single phase induction motors. It consists of two parts defined in 2.2 and 2.3.

2.2 Stationary Component of the Switch — The part of the centrifugal switch assembly mounted on the stator or end covers and carry the switching contact.

2.3 Rotating Component of the Switch — The part of the centrifugal switch assembly mounted on the shaft or rotor and governs the operation of switch contact mounted on the stationary component (see 2.2).

2.4 Screw Terminal — A terminal in which the conductor is clamped under the head of the screw. The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, clamping plate or hand-spread device.

2.5 Actuating Member — That part which is moved, pulled, pushed or turned to operate the switch mechanism.

2.6 Clearance Distance (in Air) — The shortest distance measured between conductive parts.

2.7 Creepage Distance — The shortest distance over the surface of insulation between conductive parts.

2.8 Type Tests — Tests carried out to prove conformity with the requirements of this specification. These are intended to prove the general quality and design of a given type of switch.

2.9 Routine Tests — Tests carried out on each piece to check requirements likely to vary during production.

2.10 Acceptance Tests — Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

*Specification for single-phase small ac and universal electric motors (second revision).

†IE rotechnical vocabulary : Part 35 Rotating machinery.

3. MATERIAL

3.1 The parts of the centrifugal switch may be manufactured from the following-materials or their equivalent. The materials given here are for guidance only :

<i>Sl No.</i>	<i>Part</i>	<i>Material</i>
i)	Insulated plate of stationary component and insulated base of rotating component	Tough non-ignitable insulating material like phenolic moulding (conforming to Grade 3 of IS : 1300-1966*) or laminated insulation
ii)	Actuating member	Phosphor bronze or equivalent material
iii)	Current carrying parts	Brass, copper, phosphor bronze or silver alloy
iv)	Contact	Silver or noble metal alloy or silver faced copper contacts
v)	Springs of the rotating component	Corrosion resistant steel wire or cold formed springs
vi)	Attachment fittings, screws and other non-current-carrying parts	Mild steel, aluminium alloy or insulating material

3.2 The moulded insulating material shall be resistant to water absorption which shall not depend on varnish. It shall be resistant to heat (see 12.13) and tracking (see 12.14) under normal use.

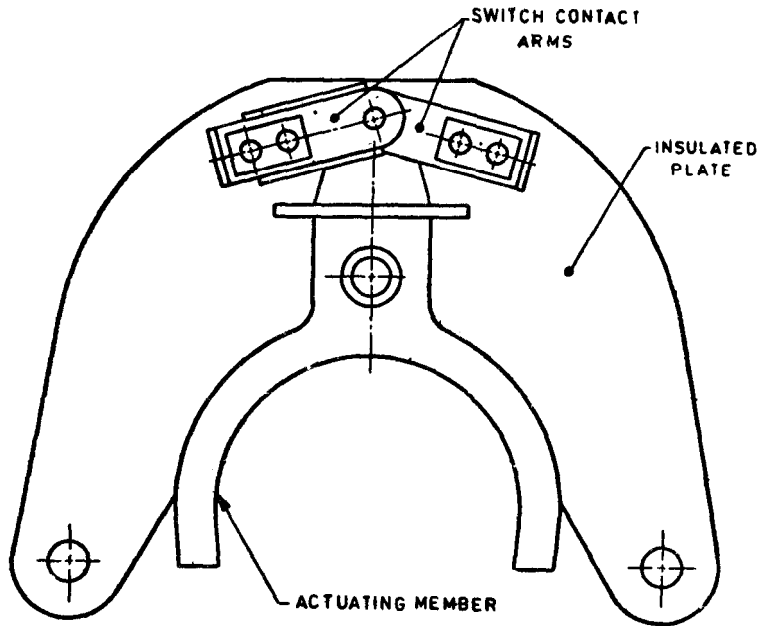
3.3 The parts made from ferrous material shall be rendered rustproof.

3.4 The switch contacts shall be rendered free from harmful oxide layer formation.

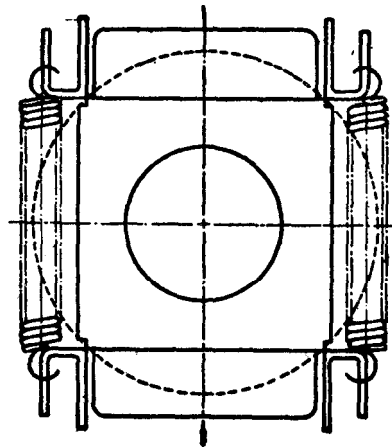
4. CONSTRUCTION

4.1 The typical construction of two types of centrifugal switches is given in Fig. 1 and 2. Any other type of construction of centrifugal switch which meet the requirements of this standard shall also be acceptable.

*Specification for phenolic moulding materials (second *revision*).



1A Stationary Component of the Switch



1 B Rotating Component of the Switch

FIG. 1 TYPICAL CONSTRUCTION OF A CENTRIFUGAL SWITCH

4.1.1 Stationary Component of the Switch — This portion of the centrifugal switch is fixed to the stationary part of the motor and incorporates the switch contacts which are actuated by the rotary component of the switch

4.1.2 Rotating Component of the Switch — This portion of the centrifugal normally works on the principle of centrifugal governor and it incorporates and actuator which actuates the switch contact mounted on the stationary component (see 4.1.1). The rotating component is normally mounted on the shaft or the rotor of the motor.

4.2 Principle of Operation — The switch is normally closed when the motor is at rest and continues to be closed till the motor attain a predetermined operating speed. Above this speed, the switch contact continues to remain open. The rotating **component** of the switch, due to its centrifugal action, actuates the **stationary** component to actuate the switch contact.

4.3 Current-Carrying Parts — The current-carrying parts shall be of robust construction and capable of carrying their rated current without excessive temperature rise (see 12.7).

4.4 Protection Against Charring of Base — If the design of the switch is such that an arc may impinge on the base during operation, the insulated base shall not char or otherwise deteriorate to impair the safety or the performance of the switch.

5. RATINGS

5.1 Voltage — The preferred rated voltage of the centrifugal switch shall be 240 V ac.

5.2 Supply Frequency -- The preferred rated frequency shall be 50 Hz.

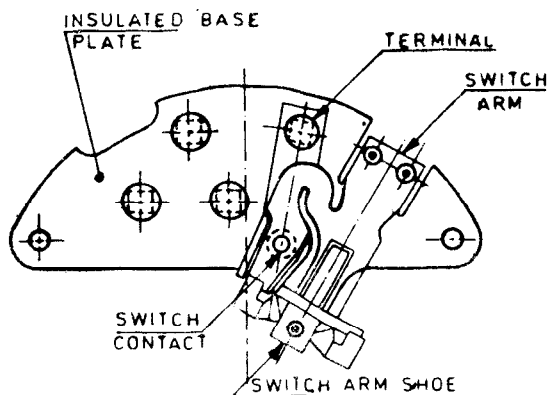
5.3 Contacts — The preferred current ratings of the switch contact shall be 15, 30 and 60 A.

5.4 Number of Poles of the Motor for Which the Switch Has Been Designed — A marking on the switch shall indicate the number of poles of the motor for which it has been designed. The number of poles of the motor for which centrifugal switch may be designed shall be 2, 4, 6 and 8.

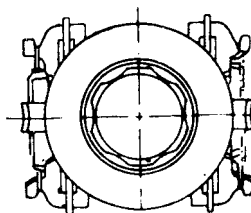
6. PERFORMANCE

6.1 The centrifugal switch in the assembled form (see 12.9.1) shall function satisfactorily under the following conditions of the rotating component:

- a) The switch contact shall open at a predetermined speed between 70 to 85 percent of the synchronous speed. The tolerance on switch opening speed shall be ± 5 percent of the declared (or agreed) speed.



2A Stationary Component of the Switch



2B Rotating Component of the Switch

FIG. 2 TYPICAL CONSTRUCTION OF ANOTHER TYPE OF CENTRIFUGAL SWITCH

- b) The speed of the rotating component at which the contact closes shall be below 80 percent of the speed at which the switch contact opens.

7. TERMINALS AND SCREWS

7.1 Terminals — The material, design and proportion of the terminals shall be such that connections made thereto do not slacken or overheat under the normal condition of use.

7.1.1 Terminals shall be designed to clamp the conductor between metal surfaces with sufficient contact pressure and without damage to the conductor.

7.1.2 The terminals shall be of sufficient size with respect to the rated current of the contact.

7.1.3 The terminals shall be so placed that there is no risk of accidental contact between live parts and the accessible metal parts.

7.2 Screws

7.2.1 Terminal screws used for gripping conductors shall be rounded or chamfered at the ends so as to prevent damage to the conductors.

7.2.2 Screwed connections, electrical or otherwise, shall withstand the mechanical stresses occurring in normal use (see 12.11).

8. ACTUATING MECHANISM

8.1 The actuating mechanism shall be sufficiently strong to withstand all normal usage encountered in service

8.2 The actuating mechanism shall be of quick make and break type.

9. CREEPAGE DISTANCES AND CLEARANCES

9.1 Creepage and clearance distances shall be not less than the values specified below:

<i>Parts</i>	<i>Distance, mm</i>	
	Creepage	Clearance
Between live parts which are separated when the contacts are open	3·0	3·0
Between live parts and earth	3·0	3·0
Between live parts and accessible metal parts or screws used for fixing the base or metal parts of the mechanism, if required to be insulated	3·0	5·0

10. ENDURANCE TEST

10.1 The centrifugal switch complying with this standard shall satisfactorily meet the requirements given in **12.10**.

11. MARKING

11.1 The components of the centrifugal switch shall be marked with the information as follows.

11.1.1 Stationary Component of the Switch

- a) Name of the manufacturer or trade-mark,
- b) Rated voltage, and
- c) Rated current.

11.1.2 Rotating Component of the Switch

- a) Name of the manufacturer or trade-mark,
- b) Number of poles, and
- c) Frequency.

11.2 BIS Certification Marking

The product may also be marked with Standard Mark.

11.2.1 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the **licence** for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

12. TESTS

12.1 Type Tests -The following shall constitute as type tests and be carried out on five pieces of centrifugal switches in new condition:

- a) Visual examination (12.3),
- b) High voltage test (12.4),
- c) Insulation resistance (12.5),
- d) Moisture resistance (12.6),
- e) Making and breaking current capacity of contacts (12.7),
- f) Contact resistance and temperature rise (12.8),
- g) Performance test (12.9),
- h) Endurance test (12.10),
- j) Screw connections (12.11),
- k) Water absorption (12.12),

- m) Resistance to heat (12.13),
- n) Resistance to tracking (12.14), and
- p) Resistance to rusting (12.15).

NOTE — The contact resistance and temperature rise tests shall be carried out after the test for making and breaking current capacity of contacts.

12.1.1 Criteria for Approval — All pieces subjected to the type tests shall pass all the tests for proving conformity with this standard. If one or more failures occurs, the testing authority, at its discretion, may call for twice the original number of pieces and subject them to all tests or to those in which failure occurred. No single failure shall be permitted in the repeat test(s).

12.1.2 Acceptance Tests — The following shall constitute acceptance tests:

- a) Visual examination (12.3),
- b) High voltage test (12.4),
- c) Insulation resistance (12.5),
- d) Moisture resistance (12.6),
- e) Contact resistance and temperature rise (12.8), and
- f) Performance test (12.9).

12.1.2.1 For carrying out the acceptance tests specified in this standard, the sampling procedure, if not specified, shall be according to Appendix A.

12.1.3 Routine Tests — The following shall constitute routine tests:

- a) Visual examination (12.3),
- b) High voltage test (12.4), and
- c) Insulation resistance (12.5).

12.2 General Conditions for Tests

12.2.1 The centrifugal switch shall be mounted and connected in the circuit as stated by the switch manufacturer.

12.2.2 Unless otherwise specified, the test shall be carried out under the prevailing atmospheric conditions.

12.3 Visual Examination — Each switch shall be visually examined for compliance with 3, 4 and 11.

12.4 Test for High Voltage

12.4.1 The switch shall satisfactorily withstand an ac voltage of 1 500 V rms for a period of one minute, when applied:

- a) between the live parts and earth with the switch contact closed,
- b) between live parts and earth with the switch contact open, and
- c) across breaks with the switch contact open.

12.4.2 The test voltage shall be approximately of sine-wave form having any convenient frequency between 40 and 60 Hz.

12.4.3 The test voltage shall be applied gradually. The initial voltage shall not exceed 30 percent of the full test voltage and shall be increased uniformly to the full voltage within 30 seconds. The full test voltage shall be maintained for one minute after which the voltage shall be diminished rapidly to 30 percent of its full value before switching it off.

12.4.4 Immediately following the test for high voltage, the insulation resistance shall be measured in accordance with 12.5.

12.4.5 As a routine test, the high voltage test shall be carried out in the form of flash test, an ac voltage of 1 500 V rms being applied for a period of five seconds between the parts specified in 12.4.1. There shall be no arcing or failure of the insulation.

12.5 Test for Insulation Resistance

12.5.1 This test may be carried out at prevailing atmospheric conditions with relative humidity not exceeding 80 percent.

12.5.1.1 The insulation resistance shall be measured at a voltage of 500 V dc after one minute of electrification between the following parts:

- a) Across breaks with the switch contacts open, and
- b) Between live parts and any other metal parts insulated therefrom including earthing terminals with the switch contact closed.

12.5.2 The insulation resistance thus measured shall not be less than 100 M Ω .

12.6 Test for Moisture Resistance

12.6.1 The switch shall be subjected to a moisture treatment for a period of 24 hours by keeping it in a humidity chamber in which the relative humidity is not less than 95 percent and temperature $27 \pm 2^{\circ}\text{C}$.

12.6.2 The insulation resistance shall then be measured in accordance with 12.5 but within two to three minutes after the removal of the switch from the conditioning chamber. Any visible drops of water shall be wiped out with the help of dry cloth or paper before determining the insulation resistance.

12.6.3 The insulation resistance so measured shall be not less than $2.0 \text{ M}\Omega$.

12.7 Test for Making and Breaking **Current** Capacity of Contacts

12.7.1 Switches when new and also after half the specified number of operations of the test for endurance (see 62.10) shall be capable of making and breaking a current, 130 percent of the rated current, at a voltage, not less than 110 percent of the rated voltage, 10 times in succession, at an interval of 30 seconds, without becoming unserviceable.

12.7.2 During this test, all metal parts normally connected to earth in service shall be earthed through a fine wire fuse of minimum length of 75 mm. This fuse element shall be copper wire not greater than 0.125 mm in diameter (see IS : 9926-1981*) which shall remain intact throughout the test.

12.8 Test for **Contact** Resistance and Temperature **Rise**

12.8.1 The centrifugal switch, when new and also after the first half of the specified number of switch cycles of the test for endurance (see 12.10) shall be capable of carrying their rated current for half an hour without exceeding 0.075 V as the voltage drop between the terminals and without the temperature rise of any part exceeding 25°C .

12.8.1.1 For the purpose of this test, the mounting of the switch should be as in the normal working conditions.

12.8.1.2 The temperature rise shall be measured by thermocouples or by other equally effective means of measurement. Thermometers may be used provided they are readable and do not materially affect the temperature rise of the parts under test.

12.8.2 For the purpose of this test the conductors of adequate current carrying capacity shall be connected to the switch terminals.

12.9 Performance Tests

12.9.1 *Operating Speed of Switch* -- The performance of the centrifugal switch for cut-off (switch contact opening) speed shall be determined using the test bench shown in Fig. 3.

*Specification for fuse-wire used in rewirable type electric fuses up to 630 volts.

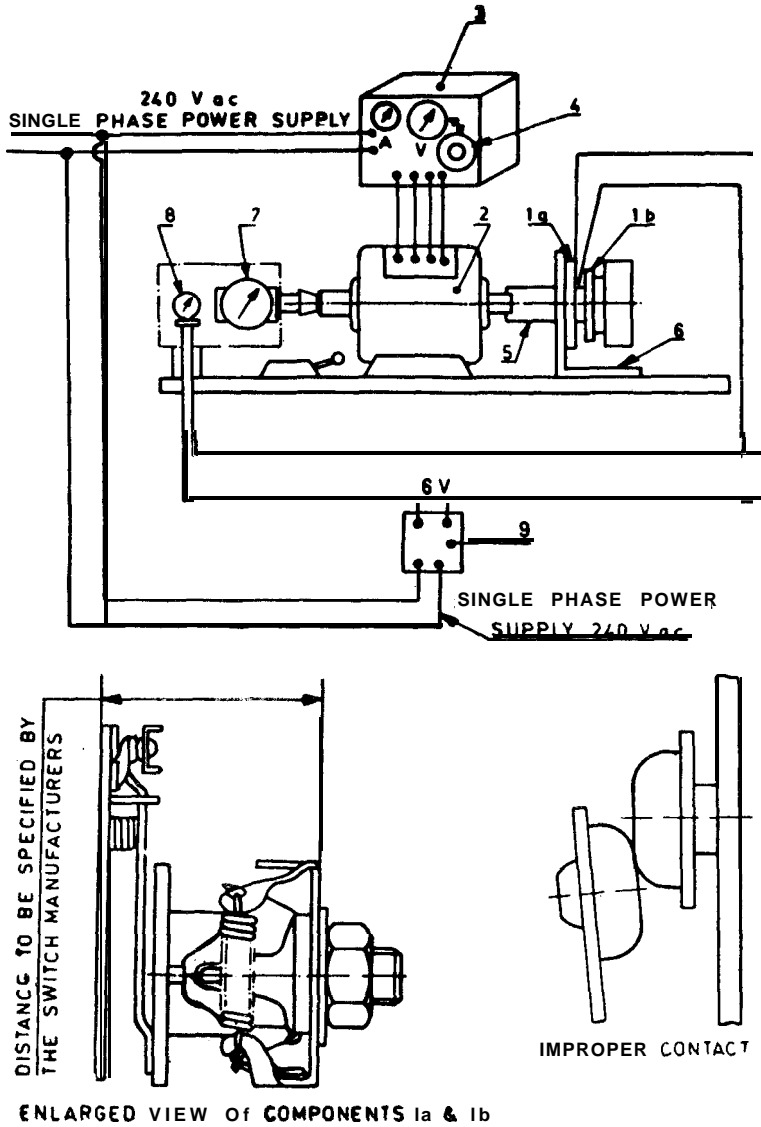


FIG. 3 TYPICAL TEST BENCH FOR PERFORMANCE TEST
AND ENDURANCE TEST

Select a stationary component of the switch (clutch plate) assembly and fix it on the test machine so that the assembly is properly made. Test the rotating component of the switch with the above selected stationary component assembly for contact opening speed given in 6.1. While doing so the cut-in speed of the switch shall be noted. The centrifugal switch shall satisfy the requirements given in 6.1.

12.10 Endurance Test

12.10.1 The centrifugal switch shall be mounted in the test machine as described in 12.9.1 (see also Fig. 3). The centrifugal switch shall be capable of making and breaking an electrical circuit at the rated voltage and rated current for 25 000 cycles at a rate not exceeding six cycles per minute at regular intervals.

12.10.2 The characteristics of the test circuit shall be such that the voltage across the contacts shall be the rated voltage of the centrifugal switch (under test) when the required test current is **flowing** and not more than 110 percent of the rated voltage on open circuit.

12.10.3 During this test, all metal parts normally connected to earth in service shall be earthed through a fine wire fuse of minimum length of 75 mm. This fuse element shall be copper wire not greater than 0.125 mm (see IS :9926-1981*) which shall remain intact throughout the test.

12.10.4 After the endurance tests, the performance of centrifugal switch shall comply with 6.1. There shall be no excessive burning or pitting of the contacts to impair its working.

12.11 Screws and, Connections

12.11.1 The test is made by means of suitable test screw driver, spanner or key applying a torque given in Table 1, the appropriate column being:

Col 2 For metal screws without heads if screw, when tightened, does not protrude from hole.

Col 3 For other metal screws and for nuts:

- a) having a hexagonal head with dimension across flats exceeding the overall thread diameter; or
- b) with a cylindrical head and a socket for a key, the socket having a cross corner dimension exceeding the overall thread diameter; or

*Specification for fuse-wire used in rewirable type electric fuses up to 650 volts.

- c) with a head having a slot or cross slots, the length of which exceeds 1.5 times the overall diameter.

TABLE 1 VALUES OF TEST TORQUE FOR SCREW CONNECTIONS

(Clauses 12.11.1 and 12.11.2)

NOMINAL DIAMETER OF SCREW	TORQUE, Nm	
	Metal Screws Without Head or Screws not Protruding from Hole	Other Metal Screws and Nuts
(1) mm	(2)	(3)
Up to and including 2.8	0.2	0.4
Over 2.8 up to and including 3.0	0.25	0.5
Over 3.0 up to and including 3.2	0.3	0.6
Over 3.2 up to and including 3.6	0.4	0.8
Over 3.6 up to and including 4.1	0.7	1.2
Over 4.1 up to and including 4.7	0.8	1.8
Over 4.7 up to and including 5.3	0.8	2.0
Over 5.3 up to and including 6.0	—	2.5

12.11.2 The screws operated in the normal use shall be tightened and loosened as follows by a suitable test screw-driver applying a torque as indicated in Table 1:

- Five times for screws operating in an internal thread in metal, and
- Ten times for screws operating in an internal thread in insulating material. These screws shall each time be completely removed and reinstated.

12.11.3 The shape of the blade of the screw driver shall suit the slot of the screw to be tested. The screw shall not be tightened in jerks.

12.12 Test for Water Absorption

12.12.1 Moulded Insulating Material — Test pieces shall be prepared from the moulded insulating materials of the centrifugal switch and subjected to the water absorption test given in **12.12.2**.

12.12.2 Clean, dry, moulded insulating part shall be removed from the metal parts and broken into pieces having a size within the range of 6 to 12 mm. These pieces weighing between 40 and 50 g shall be taken for testing.

12.12.2.1 The test pieces shall be heated to $50 \pm 2^\circ\text{C}$ for 24 hours in a dry atmosphere and then cooled in a desiccator to remove the residual moisture, if any. The conditioned test pieces shall then be weighed and immersed in distilled water for 24 h and then removed from water, the residual drops of water being removed by rolling over a piece of filter paper or dry cloth.

12.12.2.2 The test pieces shall be reweighed to the nearest milligram within 10 minutes after removal from the water. The percentage of water absorption shall be calculated from these measurements.

12.12.2.3 The water absorption by moulded insulating material shall not exceed 1.0 percent.

12.13 Test for Resistance to Heat

12.13.1 The insulated plate of the stationary components shall be kept in a heating cabinet at a temperature of 125°C for a period on one hour.

12.13.1.1 The sample shall not undergo any change impairing their further use.

12.13.2 The stationary component plate of insulated material is subjected to a ball-pressure test by means of the apparatus shown in Fig. 4.

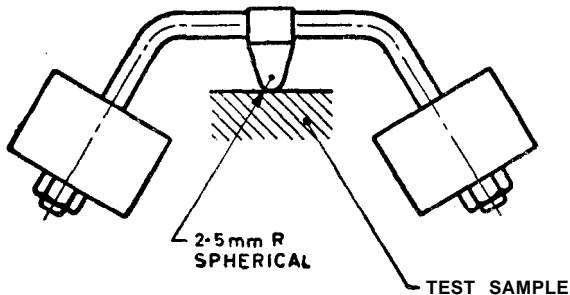


FIG. 4 BALL PRESSURE APPARATUS

12.13.2.1 The surface of the part to be tested is placed in the horizontal position and a steel ball of 5 mm diameter is pressed against this surface by a force of 20 N. The temperature of heating cabinet shall be maintained at 125°C .

IS : **11537** - 1985

12.13.2.2 After one hour, the ball is removed and the diameter of the impression shall be measured which shall not exceed 2 mm.

12.14 Test for Tracking (Applicable to Moulded Insulating Materials Only)

— This test is a type test and shall be carried out in accordance with IS : 2824-1975*. The tracking index of the moulded insulating material shall be not less than 175.

12.15 Test for Resistance to Rusting

12.15.1 All ferrous parts shall be subjected to this test.

12.15.2 All greases shall be removed from the parts to be tested by immersion in carbon tetrachloride for 10 minutes. The parts shall then be immersed for 10 minutes in an aqueous solution of 10 percent ammonium chloride at a temperature of $27 \pm 5^{\circ}\text{C}$.

12.15.3 Without drying, but after shaking off any drops of the solution, the parts shall then be placed for 10 minutes in a box containing air saturated with moisture at a temperature of $27 \pm 5^{\circ}\text{C}$. The sample shall then be dried for 10 minutes in a heating cabinet at a temperature of $100 \pm 5^{\circ}\text{C}$.

12.15.3.1 At the end of this treatment, surfaces shall show no sign of rust.

12.15.3.2 Traces of rust on sharp edges and a yellowish film removable by rubbing should be ignored.

APPENDIX A

(Clause 12.1.2.1)

SAMPLING PLAN FOR CENTRIFUGAL SWITCHES

A-1. LOT

A-1.1 In a consignment, all the switches of the same rating manufactured from the same material under similar conditions of production shall be grouped together to constitute a lot.

*Method for determining comparative tracking index of solid insulating materials under moist conditions (first revision).

A-2. SCALE OF SAMPLING

A-2.1 For judging the conformity of a lot to the requirements of the acceptance tests, sampling shall be done for each lot separately, For this purpose, the number of switches to be selected at random from each lot shall depend on the size of the lot and shall be in accordance with Table 2.

TABLE 2 SAMPLE SIZE AND ACCEPTANCE NUMBER

(Clauses A-2.1, A-3.1 and A-3.2)

LOT SIZE	SAMPLE SIZE	ACCEPTANCE NUMBER	SAMPLE SIZE FOR PERFORMANCE TEST AND ENDURANCE TEST
(1)	(2)	(3)	(4)
up to 50	5	0	2
51 to 150	8	0	3
151 to 300	13	1	5
301 and above	20	2	8

A-2.2 These switches shall be selected at random from the lot. In order to ensure the randomness of selection, procedure given in **IS:4905-1968*** may be followed.

A-3. NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

A-3.1 The switches selected at random in accordance with col 1 and 2 of Table 2 shall be Subjected to tests given in **12.1.2**. A switch failing to satisfy any of these tests shall be termed as defective. A lot shall be considered as conforming to the requirements of these tests if the number of defectives is less than or equal to the corresponding acceptance number given in col 3 of Table 2.

A-3.2 The lot which has been found as conforming to the requirements of above mentioned acceptance tests shall then be subjected to performance test and endurance test. For this purpose, the number of switches to be selected in sample shall be in accordance with col 1 and 4 of Table 2. The lot shall be considered as conforming to the requirements of these tests if no defective is found in the samples.

*Methods for random sampling.

(Continued from page 6)

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